SECTION 502 - PORTLAND CEMENT CONCRETE PAVEMENT

Delete Sec 502 and substitute the following:

502.1 Description. This work shall consist of a pavement composed of portland cement concrete, with or without reinforcement as specified, constructed on a prepared subgrade in accordance with these specifications and in conformity with the lines, grades, thicknesses and typical cross sections shown on the plans or established by the engineer.

502.2 Material. All material shall be in accordance with Division 1000, Materials Details, and specifically as follows:

Item	Section
Steel Wire Fabric for Concrete Pavement	1036.2
Concrete Curing Material	1055
Material for Joints	1057.1

All material, proportioning, air-entrainment, mixing, slump and transporting for portland cement concrete shall be in accordance with Sec 501.

502.3 Equipment. Equipment and tools necessary for handling material and performing all parts of the work shall be satisfactory to the engineer as to design, capacity and mechanical condition. The equipment shall be at the job site sufficiently ahead of the start of construction operations to be examined thoroughly by the engineer and shall comply with the following requirements.

502.3.1 Batching Plant and Mixer. The mixer, water measuring equipment and weighing (mass determination) and batching equipment shall be in accordance with Sec 501.

502.3.2 Hauling. Trucks for transporting mixed concrete shall be in accordance with Sec 501. Consideration will be given for the use of an approved type of non-agitating equipment for transporting central mixed concrete provided the discharge of the concrete is completed within 30 minutes after the introduction of the mixing water to the cement and aggregates. Bodies of non-agitating hauling equipment shall be smooth, mortar-tight metal containers capable of discharging the concrete at a satisfactory, controlled rate without segregation.

502.3.3 Forms. Side forms, except as otherwise permitted, shall be of metal, with a base width sufficient to support the finishing equipment to be used. The height shall be equal to the edge thickness of the pavement. Each form section shall be straight and free from bends and warps. No section shall show a variation greater than 1/8 inch (3 mm) in 10 feet (3 m) from the true plane surface on the top, and 1/4 inch (6 mm) in 10 feet (3 m) along the face of the form. The method of connecting form sections shall ensure a tight, neat joint. Forms shall be clean and coated with a form release agent before concrete placement. Forms for curved form lines shall comply with the grade and alignment in accordance with Sec 502.5.1, except that straight steel form sections 10 feet (3 m) or less in length may be used for form lines having a radius greater than 200 feet (60 m). Special forms of wood or steel will be permitted for curved form lines having a radius of 200 feet (60 m) or less, and may be permitted if approved by the engineer in other special cases where it is not practicable to use standard pavement forms. Straight steel form sections 5 feet (1.5 m) long will be acceptable for curved form lines having a radius of not less than 100 feet (30 m). Forms shall be of sufficient rigidity to prevent distortion in edge alignment due to pressure of the concrete. Wood forms shall not be used as a track for operating paving and finishing equipment.

502.3.4 Vibrators. Vibrators used for full width vibration of the concrete shall be of the internal type. They shall not come in contact with the reinforcement, load transfer devices, subgrade or side forms. Vibrating equipment shall be operated in accordance with the manufacturer's recommendation at a frequency to provide satisfactory results, but shall not be less than 4500 impulses per minute. Hand vibrators shall have a frequency of not less than 4500 impulses per minute. The contractor shall have a satisfactory tachometer available at all times for checking the vibration frequency.

502.3.5 Surface Finishing Equipment.

502.3.5.1 Texturing Equipment. A wire comb, fabric drag, diamond grinding or other means may be used. The final surface texture shall be in accordance with Sec 502.10.3.

502.3.5.2 Fabric Drag. If the contract specifies concrete to be tinted, a fabric drag consisting of a seamless strip of burlap or cotton of not less than the width of the pavement shall be provided. To obtain a satisfactory finish, it may be necessary to ravel out the cross threads of the trailing 2 or 3 inches (50 or 75 mm) of the drag. Brooms of an approved type may be provided in lieu of the fabric drag. The brooms shall not be less than 18 inches (450 mm) wide, made from good quality bass or bassine fiber not more than 5 inches (125 mm) long.

502.3.6 Concrete Saw. If sawed joints are required, equipment shall be provided complete with either an abrasive wheel or a diamond-edge water-cooled blade, capable of providing a groove of the specified dimensions in the hardened concrete.

502.3.7 Equipment for Sealing Joints. An approved double boiler-type heating kettle equipped with a mechanical agitator and a satisfactory temperature indicating device will be required. The equipment shall be capable of heating the joint sealing material uniformly without damage.

502.3.8 Auxiliary equipment shall be available at all times as follows:

(a) A minimum of one footbridge designed to be readily transported from place to place and having no part in contact with the pavement.

(b) Long-handled floats, each having a blade at least 3 feet (900 mm) long and 6 inches (150 mm) wide.

(c) Metal dyes with beveled face numerals not less than 3 inches (75 mm) nor more than 5 inches (125 mm) high and thick enough to make an indentation of 1/4 inch (6 mm). A satisfactory dye shall be used for marking the point designated by the station number.

(d) Sufficient burlap, waterproof paper or plastic film for the protection of the pavement in case of rain or breakdown of the curing equipment.

(e) A manually operated long handle wire comb approximately 2 feet (600 mm) wide with wire size and spacing in accordance Sec 502.3.5.1.

502.3.9 Field Laboratory. The contractor shall provide a Type 4 Field Laboratory in accordance with Sec 601. No direct payment will be made for providing the laboratory.

Construction Requirements

502.4 Weather Limitations. Unless otherwise authorized in writing by the engineer, mixing and concreting operations shall be discontinued when a descending ambient temperature away

from artificial heat reaches 40 F (5 C) and not resumed until an ascending ambient temperature away from artificial heat reaches 35 F (2 C).

502.4.1 If approval has been granted for the contractor to place the concrete while the ambient temperature is at or lower than 40 F (5 C), the contractor shall take precautionary measures to prevent damage by freezing, such as heating mixing water, heating aggregates or applying heat directly to the contents of the mixer. Aggregates shall not be heated higher than 150 F (65 C), and the temperature of the aggregates and mixing water combined shall not be higher than 100 F (40 C), when the cement is added. Unless otherwise authorized, the temperature of the mixed concrete when heating is employed shall not be less than 50 F (10 C) and not more than 80 F (30 C) at the time of placement. Cement or fine aggregate containing lumps or crusts of hardened material or frost shall not be used. Concrete shall not be placed upon a frozen subgrade except with written approval of the engineer.

502.4.2 All concrete shall be effectively protected from freezing for a period of at least 5 days after it has been placed or until a minimum compressive strength of 3000 pounds per square inch (21 MPa) has been attained. Protection will be required for not more than 10 days. Regardless of precautions taken, the contractor shall assume all risks, and all frozen concrete shall be replaced at the contractor's expense.

502.5 Setting Forms. Forms shall be set so that they rest firmly throughout their length upon the thoroughly compacted subgrade. Any subgrade which is more than 1/2 inch (13 mm) below the established grade at the form line shall be brought to grade for a sufficient width, outside the area required by the pavement, to support the forms adequately, and shall be thoroughly rolled. Any variations, whether below or above grade, shall be brought to true grade.

502.5.1 Paving forms shall be sufficiently supported to avoid displacement during paving operations. Both straight and curved forms shall be supported in such position that the face of the form shall be vertical on tangents and perpendicular to the superelevated section on curves. The top of the form shall not vary more than 1/8 inch (3 mm) from the true grade line during placing, compacting and finishing operations. The form alignment shall not vary more than 1/4 inch (6 mm) from the true alignment.

502.5.2 Forms shall be set ahead of concrete placement a sufficient distance to provide time to check their line and grade and provide continuous paving operation.

502.6 Conditioning of Subgrade. When forms have been securely set to grade, the subgrade shall be brought to proper cross section in accordance with Sec 209. The final checking for proper crown and elevation of the subgrade shall be performed in the presence of the engineer after all equipment traffic on the subgrade has ceased and as close as is practicable to the area of concrete placement. Low areas of treated bases shall be filled only with concrete integral with the pavement. No direct payment will be made for the concrete used to fill these low areas.

502.7 Proportioning and Mixing Concrete. Concrete shall be proportioned and mixed by truck or central mixers in accordance with Sec 501. This shall consist of batching all aggregate, cement and water by means of automatic weighing (mass determination) or metering, with all additives dispensed automatically and interlocked with the automatic weighing (mass determination) or metering controls. For central mixed concrete, the mixing cycle shall be timed and interlocked with the weight (mass) batch cycle. The weight (mass determination) setting controls shall be equipped so that they may be locked when directed by the engineer. The automatic batching equipment shall be capable of conversion to manual operation if necessary. Manual operation will not be permitted beyond 24 hours after breakdown in the automatic equipment, except by written approval of the engineer. Where a project includes paving that

cannot be performed in a normal sequence, the contractor will be permitted to place up to a maximum of 7000 square yards (5800 m^2) using manual batching methods.

502.7.1 For all contracts having a total of not more than 20,000 square yards (16700 m^2) of concrete base course and concrete pavement combined, manual batching methods will be permitted.

502.7.2 For all contracts having a total of more than 20,000 square yards (16700 m^2) of concrete base course and concrete pavement combined, automatic, fully interlocked batching control approved by the engineer will be required.

502.8 Placing Concrete. The concrete shall be deposited over the entire width of the subgrade between forms in such manner as to prevent segregation and to require as little rehandling as practicable. Mixers used for pavement construction, including truck mixers and trucks used for transporting concrete, will not be permitted to discharge concrete by chute or by dumping directly on the subgrade, prepared base or previously placed concrete except for areas to be hand finished or for isolated pavement lanes less than 2000 feet (600 m) long. Concrete shall be thoroughly vibrated along the forms or sides and along expansion and key type longitudinal joints. Attachments on finishing machines to vibrate the concrete adjacent to forms and longitudinal joints will be permitted provided satisfactory results are attained. Care shall be taken that the vibrator does not penetrate the subgrade or dislodge or move the joints. The vibrating shall be sufficient to produce a smooth pavement edge. Honeycomb in the edge may be cause for rejection of the pavement.

502.9 Strike-off of Concrete and Placement of Reinforcement. Following the placing of the concrete, it shall be struck-off so that when the concrete is properly consolidated and finished, the surface of the pavement will be at the proper elevation and cross section. Reinforced concrete pavement shall be placed in two layers. The entire width of the bottom layer shall be struck-off to such length and depth that the sheet of wire fabric may be laid full length on the concrete in its final position without further manipulation. The reinforcement shall be placed directly upon the concrete, and the top layer of the concrete placed, struck-off and screeded. Any portion of the bottom layer of concrete which has been placed more than 30 minutes without being covered with the top layer shall be removed and replaced with freshly mixed concrete at the contractor's expense.

502.9.1 Tie bars shall be supported in the proper position by chairs driven into the subgrade, or may be placed by approved mechanical methods prior to the consolidation of the concrete after it has been struck-off.

502.9.2 Wire fabric and tie bars shall be free from dirt, oil, paint, grease, loose mill scale and thick rust which could impair bond of the steel with the concrete. Thin, powdery rust need not be removed.

502.10 Final Strike-off, Consolidation and Finishing. Machine finishing by extrusion methods or by vibrating and screeding processes will be required for all pavement except as permitted in accordance with Sec 502.10.7. After the final course of the concrete has been placed, it shall be struck-off and thoroughly vibrated until concrete of a uniform and satisfactory density is attained. The surface of the pavement shall be of uniform texture and to the proper grade and typical section. Excessive screeding over a given area shall be avoided. Finishing machines shall be kept in satisfactory repair and adjustment and shall be operated without lift, wobbling, or other variation tending to affect a precision finish. While operating, a roll of concrete shall be maintained in front of the full length of all screeds so that the vibrating and screeding work will be fully effective.

502.10.1 Consolidation. Concrete shall be consolidated by vibrating the mixture promptly following placement. Vibrating tubes shall extend into the concrete the distance necessary to provide adequate consolidation. Vibrators shall be operated only when the machine to which they are attached is moving.

502.10.2 Added Finishing Water. Moisture shall not be applied to the surface of the pavement in any form except for emergency conditions. When emergency conditions exist and it becomes necessary to apply additional moisture to the surface of the pavement in order to complete the final finishing operation, water may be applied but only in the form of a fine pressure spray. Under such conditions, placement of additional concrete on the subgrade shall be discontinued until the emergency conditions cease to exist.

502.10.3 Surface Texture. After surface irregularities have been removed, the concrete shall be given a uniformly roughened surface finish. The surface texture shall be tested in accordance with ASTM E 965, except as modified herein, to ensure the texture is adequate for desired friction characteristics. The test locations will be determined by the engineer in accordance with Sec 502.17 and will be at a point located transversely to fall in the outside wheelpath.

502.10.3.1 Plastic sample containers for ASTM E 965 testing shall be of a rigid material that will crack or break if the container is deformed. Damaged or deformed containers shall not be used.

502.10.3.2 The results of ASTM E 965 shall show an average texture depth of any lot, as defined in Sec 502.17.1, to have a minimum value of 1.00 mm. Any lot showing an average of less than 1.00 mm, but equal to or greater than .80 mm, will be accepted as substantial compliance, except the contractor shall amend texturing operations to achieve the required 1.00 mm minimum depth. The contractor shall not continuously pave with an average texture depth of less than 1.00 mm. Any lot showing an average texture depth of less than 0.80 mm shall require diamond grinding of the pavement represented by this lot to attain the necessary texture. Any individual test showing a texture depth of less than 0.70 mm shall require diamond grinding of the pavement represented by this test to attain the necessary texture of 1.00 mm. Limits of any failing individual test shall be determined by running additional tests at 100 foot (30 m) intervals before and after the failing test location. All testing of the surface texture shall be completed no later than the day following pavement placement.

502.10.3.3 Diamond grinding, unless only used for bump correction, shall be across the entire width of the pavement and shall be continuous for a minimum of 0.1 mile (1 km).

502.10.4 Edging at Forms and Joints. After the final finish, but before the concrete has taken its initial set, the edges of the pavement along each form line, and on each side of transverse expansion joints and construction joints shall be worked with an edging tool having a radius of approximately 3/8 inch (10 mm). A well-defined and continuous radius having a smooth, dense finish shall be produced. The surface of the pavement shall not be unduly disturbed by tilting of the tool during use. Tool marks on the pavement shall be eliminated by brooming or dragging the surface. In doing this, the rounding of the corner of the pavement shall not be disturbed. All concrete on top of the joint filler shall be completely removed. All joints shall be tested with a straightedge before the concrete has set, and correction made if one side of the joint is higher than the other.

502.10.5 Station Numbers. The contractor shall indent station numbers into all pavement immediately following the final finishing operations and before the concrete takes its final set. The numbers shall be placed at alternating full stations as ascertained by measurements determined by the engineer. Equations in stationing shall also be marked in the pavement. On undivided pavement, the station numbers shall be on the left side of the pavement with respect

to the ascending stationing and shall be on the pavement edge unless an integral curb is involved, in which case the numbers shall be placed on the face of the curb. On divided pavement, station numbers shall be placed on the median side of each pavement. The numbers shall be placed facing the centerline of the pavement, or the centerline of each pavement in the case of divided pavements. The numbers shall be placed on a troweled area of the finished surface. No direct payment will be made for marking station numbers.

502.10.6 Modified Machine Finishing. For isolated pavement lanes over 200 feet (60 m) long but less than 2000 feet (600 m) long, all machine finishing equipment will be required except that a mechanical spreader will not be required. The final surface texture may be applied manually with a wire comb in accordance with Sec 502.3.8.

502.10.7 Hand Finishing. Hand finishing shall be in accordance with Sec 502.10. Mechanical finishing equipment will not be required. The final surface texture may be applied manually with a wire comb in accordance with Sec 502.3.8. Compacting and finishing pavement by hand methods will be permitted:

(a) For all curves having a form line radius of less than 200 feet (60 m) or where wood forms are used.

(b) For all irregular shaped areas.

(c) For pavement lanes less than 200 (60 m) feet long.

(d) For pavement lanes less than 10 (3 m) feet wide.

(e) For bridge approach and pavement to first expansion joint.

(f) When a breakdown of the mechanical compacting and finishing equipment occurs or in the event of some other emergency. After a breakdown, only material which has already been proportioned and which may become unsatisfactory for use may be finished by hand.

502.11 Joints. Joints shall be of the specified type and dimensions, and constructed at the locations shown on the plans or as approved by the engineer. Where joints are preformed, the form or joint shall be set and securely fastened to ensure the joint being in the required position when the concrete is finished. Dowels and tie bars in their final position shall be parallel to the subgrade and perpendicular to the line of the joint. Dowel supporting assemblies shall conform to one of the types shown on the plans. The concrete shall be placed so that it will not displace or disarrange the joint installations.

502.11.1 Expansion Joints. Expansion joints shall extend for the full cross section of the concrete pavement. Filler placed prior to the placement of the concrete shall be installed with a removable cap or edging bar to serve as a guide for edging the joint and protection for the filler during the placing and finishing of the concrete. Joints constructed after the placement of concrete shall be sawed full depth and the exposed edges shall be ground to a chamfer of 3/8 inch (10 mm). The filler shall rest snugly on the subgrade from form to form. The joints shall be sealed in accordance with Sec 502.11.4. Upon removal of the forms, any struts or fins of concrete extending across the joint shall be removed to the full width of the joint and the full thickness of the pavement.

502.11.2 Construction Joints. Construction joints shall be made at the close of each day's work or when the work is stopped or interrupted for more than 30 minutes. No transverse construction joint shall be constructed within 10 feet (3 m) of an expansion or contraction joint. For transverse contraction joint spacing of 20 feet (6 m) or less, the transverse construction joint

shall be located within the normal sequence of contraction joint spacing as shown on the plans. Construction joints shall be constructed perpendicular to the top surface and the centerline of the pavement. Construction joints may be formed with a timber header or may be sawed full depth. The final joint shall conform to the cross section of the pavement. Before paving operations are resumed, all surplus concrete and other refuse shall be removed from the subgrade.

502.11.3 Sawing. Unless otherwise provided, all transverse contraction joints and all Type L longitudinal joints in the pavement shall be sawed with the joint groove cut to the dimensions shown on the plans. If the groove for poured type transverse joints is cut prior to removal of the forms, the groove shall be cut as close as is practicable to the pavement edge, and the resulting crescent shaped plug in the groove, immediately adjacent to the form, will be acceptable. For intersections and irregular pavement, joints shall be sawed at locations as approved by the engineer. Sawing of the joints shall begin as soon as the concrete has hardened sufficiently to permit sawing without excessive raveling. All joints shall be sawed before uncontrolled shrinkage cracking takes place. The sawing of any joint shall be omitted if a crack occurs at or near the joint location prior to the time of sawing. Sawing shall be discontinued when a crack develops ahead of the saw. The engineer reserves the right to have the contractor install preformed type joints on multiple width construction when the use of sawed joints fails to prevent random cracking. Any non-reinforced concrete pavement with random cracking not controlled by dowels or tie bars shall be removed and replaced using dowels or tie bars as appropriate to the nearest controlled joint at the contractor's expense.

502.11.4 Sealing Joints. All sawed contraction joints and sawed or formed expansion joints shall be sealed with joint sealing material before the pavement is opened to any traffic, including construction traffic. Immediately prior to sealing, the joints shall be thoroughly cleaned and dried. The sealing material shall be heated to the pouring temperature recommended by the manufacturer. Any material which has been heated above the maximum safe heating temperature will be rejected. The sealing material shall be installed in such a way as to fill the joint opening uniformly from the bottom to approximately 1/8 inch (3 mm) from the top. Any excess material shall be removed from the pavement surface.

502.11.5 Joint Filler at Railroad Crossings. Bituminous filler for use between railroad crossing approach slabs and the timber crossing shall be an approved commercial bituminous mixture in accordance with Sec 401.3.8. The mixture shall be tamped into a firm and compacted state.

502.12 Curing. Immediately after the finishing operations have been completed and as soon as marring of the concrete will not occur, the entire surface and exposed edges of the newly placed concrete shall be covered and cured in accordance with one of the following methods. The concrete shall not be left exposed for more than 30 minutes between stages of curing or during the curing period.

502.12.1 White Pigmented Membrane. After the free water has left the pavement surface, the entire surface shall be sealed by hand or machine spraying with a uniform application of white pigmented membrane curing material. The contractor shall provide satisfactory equipment to ensure uniform coverage of curing material, without loss, on the pavement at the rate of one gallon for each 150 square feet (0.27 L/m^2). If rain falls on the newly coated pavement before the film has dried sufficiently to resist damage, or if the film is damaged in any other way, the contractor shall apply additional curing material to the affected portions. All areas cut by finishing tools subsequent to the application of the curing material shall immediately be given new applications at the rate specified above. If hair-checking develops before the membrane can be applied, the concrete shall be initially cured with wet burlap in accordance with Sec 502.12.3 before the membrane is placed.

502.12.2 Waterproofed Paper, Polyethylene Sheeting and Polyethylene-Burlap Sheeting. As soon as the concrete has set sufficiently to prevent marring, the top surface of the pavement shall be covered with units of waterproofed paper, white polyethylene sheeting or white polyethylene-burlap sheeting, which shall be lapped not less than 18 inches (450 mm). If polyethylene-burlap sheeting is used, the burlap shall be thoroughly dampened prior to placing and shall be placed next to the concrete. All coverings shall be so placed and weighted that they remain in contact with the pavement surface and edges for not less than 72 hours after the concrete has been placed. If hair-checking develops before the covering can be applied, the concrete shall be initially cured with wet burlap in accordance with Sec 502.12.3 before the covering is placed.

502.12.3 Burlap. The top surface of the pavement shall be temporarily covered with thoroughly damp burlap after the concrete has set sufficiently to prevent marring of the surface. Burlap shall be handled in such manner that contact with earth or other deleterious substances is avoided. All new or contaminated burlap and all burlap which has been used for purposes other than the curing of concrete shall be thoroughly washed before being used. The burlap shall be kept thoroughly wet until removed for application of the final curing material. Neither the top nor the edge of the pavement shall be left unprotected for more than 30 minutes. When the burlap is removed, curing shall be continued by one of the approved methods.

502.13 Removing Forms. Forms shall be removed carefully so as to avoid damage to the pavement. Honeycombed areas will be considered as defective work and shall be immediately repaired. If the forms are removed prior to 72 hours after placing concrete, the sides of the pavement shall be cured by one of the methods specified above. Any trench excavated for the forms shall be entirely backfilled so no water will stand next to the pavement.

502.14 Surface Test. The pavement surface shall be thoroughly tested for smoothness by profilographing or straightedging as indicated. Testing applicable to this specification, except straightedging, shall be performed by the contractor in the presence of the engineer.

502.14.1 Straightedging. As soon as practical, the engineer will straightedge all segments of the paved surface not profilographed, including shoulder areas between rumble strips. Any variations exceeding 1/8 inch in 10 feet (3 mm in 3 m) will be marked. Areas more than 1/8 inch (3 mm) high shall be removed in accordance with Sec 502.14.6.2. If areas more than 1/8 inch (3 mm) low exist, appropriate correction shall be required for suitable smoothness.

502.14.2 Profilographing. Profilographing is applicable to the surface of all mainline paving, auxiliary lanes, turning lanes and ramps for projects with a sufficient amount of continuous concrete pavement. A sufficient amount of continuous concrete pavement will be such that a project, or combination of projects, consists of more than 0.5 mile (1 km) of total profilographable pavement. Profilographing may be waived by the engineer if staging of the overall project affects the normal paving operation, such as multiple entrance lane gaps, lane staging, etc., or if multiple profilograph exceptions continuously exist eliminating smoothness requirements on a large portion of the same roadway. Upon waiver, all smoothness requirements shall be in accordance with Sec 502.14.1.

502.14.2.1 All wheels of the profilograph shall be placed on the new pavement, with stationing based on the center wheel.

502.14.2.2 Profilographing will not be required for the following:

(a) Bridge decks, bridge approach slabs and concrete approach pavements.

(b) Pavement on horizontal curves with centerline radius of curve less than 1000 feet (300 m) and pavement within the superelevation transition of such curves.

(c) Pavement on vertical curves having a "K" value less than 90 and a length less than 500 feet (150 m).

(d) Pavement in width transitions.

(e) Fifty feet (15 m) in direction of travel on each side of utility appurtenances such as manholes and valve boxes.

(f) Fifty feet (15 m) in direction of travel on each side of intersecting routes with special grade transition.

(g) Portland cement concrete shoulders.

(h) Any lane which abuts an existing lane not constructed under the same contract.

(i) Interruptions designated by the engineer which provide independently placed sections shorter than 50 feet (15 m). Interruptions designated by the contractor's operations shall be in accordance with Sec 502.14.5.12.

(j) The last 15 feet (5 m) of any section where the prime contractor is not responsible for the adjoining surface.

(k) The first or last 12.5 feet (4 m) of a pavement section adjoining any above exception area.

502.14.3 Equipment. The profilograph shall be a California type as approved by the engineer. The equipment furnished shall be supported on multiple wheels having no common axle. The wheels shall be arranged in a staggered pattern such that no two wheels cross the same bump at the same time. The pavement profile is recorded from the vertical movement of a sensing wheel attached to the frame at midpoint and is in reference to the mean elevation of the 12 points of contact with the road surface established by the support wheels. The profilogram is recorded with a scale of one inch equals one inch (1 mm equals 1 mm) vertically and one inch equals 25 feet (1 mm equals 300 mm) longitudinally. The profilogram line drawn by the profilograph will be referred to as the profile trace in these specifications.

502.14.4 Calibration. All profilographs used shall be calibrated at least annually on a test section established by MoDOT. The contractor's calibration profile index shall not vary more than 2.0 inches per mile (30 mm/km) from a standard profile index produced by a MoDOT profilograph.

502.14.4.1 Longitudinal calibration consists of pushing the profilograph over a pre-measured test distance and determining the scale factor by dividing the premeasured test distance by the length of the paper in inches (millimeters). This factor shall be 25 (300), one inch equals 25 feet (25 mm equals 7.622 m). If not, the machine shall be adjusted until the scale factor is 25 (300) plus or minus 0.2 percent.

502.14.4.2 Vertical calibration consists of sliding a pre-measured calibration block, measured to the nearest 0.01 inch (0.25 mm), under the sensing wheel while the profilograph is stationary. The measurement of the vertical trace line from the base line to the peak and return shall be the same as the calibration block. The trace line must return to the base line. No tolerance will be allowed.

502.14.4.3 A profilograph equipped with automatic profile trace reduction capabilities shall be checked by comparing the machine's results with the results obtained by the engineer. This shall be done for the profile trace obtained on the MoDOT test section. The results and the profilogram shall be submitted to the engineer. The results of the comparison may not differ by more than 2.0 inches per mile (30 mm/km).

502.14.4.4 The contractor shall furnish certification that the 25-foot (7.622 m) profilograph test and evaluation was conducted by an operator trained in the use of profilograph equipment and with sufficient experience to demonstrate the operator's competence.

502.14.5 Test Procedures and Reporting.

502.14.5.1 A profilogram shall be made for each continuous pavement section of 50 feet (15 m) or greater completed during each day's placement. A section is defined where paving begins and terminates at a day's work joint. Interruptions designated by the engineer which cause placement to cease and begin at a new location will be considered as a separate section for that day's operation if the separate section is greater than 250 feet (75 m).

502.14.5.2 The contractor shall furnish the profilogram and its evaluation to the engineer. The testing shall be done by a certified operator in the presence of the engineer. The testing procedure and the evaluation of the profilogram shall be done in accordance with this specification and MoDOT Test Method T59. The profilogram and evaluation shall be furnished to the engineer no later than the end of the next working day following placement of the pavement and within two days after corrective grinding. The evaluation shall be reported on an approved form for each day's placement. Separate sections in a day's placement shall be appropriately separated on the day's report for MoDOT use. Standard forms for reporting results may be obtained from MoDOT.

502.14.5.3 The engineer may test the surface or re-evaluate the profilogram for comparison and assurance purposes. If these tests or re-evaluations indicate the contractor-furnished profilograms are not accurate within 3.0 inches per mile (45 mm/km), the engineer may test the entire project length. If the entire project length is tested, the contractor will be charged for this work at the rate of $500.00 per lane mile ($310.00 per lane kilometer). Furnishing inaccurate test results may result in decertification of the operator.

502.14.5.4 All objects and foreign material on the pavement surface, including protective covers, if used, shall be removed by the contractor prior to testing and, if appropriate, protective covers shall be properly replaced by the contractor after testing.

502.14.5.5 The sensing wheel shall be lifted, rotated to take slack out of the linkage, and lowered to the pavement surface at the starting point prior to testing.

502.14.5.6 The profilograph shall be propelled at walking speed in the paths in accordance with Sec 502.14.5.10 for each section of pavement. Propulsion may be provided by personnel pushing manually or by a suitable propulsion unit. Speed of the profilograph shall be decreased if excessive spikes are encountered on the trace. The actual stationing shall be noted on the profilogram at least every 200 feet (50 m). Station referencing is used to accurately locate deviations greater than 0.40 inch (10 mm).

502.14.5.7 A location indicator for lateral placement shall be used. The back end of the profilograph shall be kept in the required path on horizontal curves except where profilographing is not required in accordance with Sec 502.14.2.2(b).

502.14.5.8 The actual stations shall be shown on the profilogram at least every 200 feet (50 m) for necessary bump referencing. The stations may be marked on the trace by manual placement of a vertical mark when the sensing wheel reaches the station. The corresponding station shall be written at the mark. This vertical mark will reference the upward direction of the trace.

502.14.5.9 Both ends of the profilogram shall be labeled with the stationing, lane designation, position or track on the pavement, the direction the pavement was placed and the date placed.

502.14.5.10 Pavement profiles shall be taken 3 feet (1 m) from and parallel to each travelway edge and as directed by the engineer. Each profile line will be incorporated into the section report as separate tracks.

502.14.5.11 Sections shall be divided into segments of 0.1 mile (0.1 km) with the exception of the last segment. If the last segment is greater than 250 feet (75 m) and less than 0.1 mile (0.1 km), then the segment shall be considered as a 0.1 mile (0.1 km) segment. If the last segment is 250 feet (75 m) or less in length, the profilogram for that segment shall be included in the evaluation for the adjacent segment in that section.

502.14.5.12 If an independently placed section required by the plans or the engineer is between 50 feet and 250 feet (15 m and 75 m), or an independently placed section caused by the contractor's operation is less than 50 feet (15 m), a profilogram shall be made for that section and included in the evaluation of the most recently placed adjoining segment of another day’s placement.

502.14.5.13 The last 12.5 feet (0.4 m) of a pavement section and the construction header shall be included in the profilogram of the next day’s placement.

502.14.5.14 A profile index shall be calculated from the profilogram for each segment of all profile trace lines and for the overall section. A report for each day’s placement shall be completed. A day's report may consist of more than one section index if a bridge or a designated interruption is encountered in a day's placement. The profile index shall be calculated by summing the vertical deviations of the profile trace above or below the reference line. The units of this measure shall be inches per mile (mm/km).

502.14.6 Surface Corrections. Bump correction or smoothness correction or both may be required after the initial smoothness report is performed to achieve a final report. If the initial report has no corrections in accordance with Secs 502.14.6.3 and 502.14.6.5, it will serve as the final report.

502.14.6.1 If an average profile index of 45.0 inches per mile (711 mm/km) for pavements having a final posted speed greater than 45 mph (70 km/h), or 65.0 inches per mile (1026 mm/km) for pavements having a final posted speed of 45 mph (70 km/h) or less, is exceeded in any daily paving operation, the paving operation will be suspended and will not be allowed to resume until corrective action approved by the engineer is taken by the contractor.

502.14.6.2 Corrective action to improve the average profile index shall be accomplished by diamond grinding or by use of an approved device designed for that purpose. The use of a bush hammer or other impact device will not be permitted. The final surface of the corrected concrete pavement shall be such that the texture is comparable to adjacent sections that do not require correcting. Satisfactory longitudinal grinding is acceptable as the final surface of the corrected pavements. All corrective work shall be completed prior to determination of pavement thickness.

502.14.6.3 High points on the profile trace that correspond to high points or bumps on the pavement surface shall be separately identified. All bumps greater than 0.40 inch (10 mm) in height over a 25-foot (7.622 m) span, as indicated on the profile trace, shall be corrected. The corrected bumps will be considered satisfactory when measurements by the profilograph show that the bumps are 0.40 inch (10 mm) or less in height over a 25-foot (7.622 m) span. Station referencing or additional profiles may be used to accurately locate deviations greater than 0.40 inch (10 mm).

502.14.6.4 After removing all individual deviations greater than 0.40 inch (10 mm) in height, an intermediate profilogram report for the appropriate section shall be provided. The report shall provide segment indexes for the entire day's section after initial bump correction. The intermediate report will serve as the final report if all average profile segment indexes are below the limits in accordance with Sec 502.14.6.5.

502.14.6.5 Correction above the individual deviations of 0.40 inch (10 mm) shall be performed if necessary to reduce any average profile segment index to 30.0 inches (474 mm) or less per mile (km) for pavements having a final posted speed greater than 45 mph (70 km/h), or 45.0 inches (711 mm) or less per mile (km) for pavements having a final posted speed of 45 mph (70 km/h) or less. On pavement segments where corrections are necessary, additional profiles shall be made to verify corrections have produced an average profile segment index within the limits noted above. Upon correction, a final report will be performed.

502.14.6.6 The final surface of the corrected concrete pavement shall be such that the texture is comparable to adjacent sections that do not require correcting. Satisfactory longitudinal grinding is acceptable as the final surface of the corrected pavements.

502.15 Opening to Traffic. The concrete pavement shall not be opened for light traffic until the concrete is at least 72 hours old and has attained a minimum compressive strength of 3000 pounds per square inch (21 MPa). The pavement shall not be opened to all types of traffic until the concrete is at least 72 hours old and has attained a minimum compressive strength of 3500 pounds per square inch (24 MPa). If high early strength concrete is used, the pavement may be opened to all types of traffic when the concrete has attained a minimum compressive strength of 3500 pounds per square inch (24 MPa). Compressive strength will be determined by tests made in accordance with MoDOT methods. Pavement shall be cleaned prior to opening to traffic.

502.16 Slip-Form Construction. At the option of the contractor, pavement may be constructed by the use of sliding form methods. All applicable provisions in accordance with Sec 502 shall be followed. In addition, the following provisions shall apply.

502.16.1 Subgrade and Base. If an aggregate base course is specified for the pavement, it shall be constructed in accordance with Sec 304 and the slip-form paver shall operate on the aggregate base. After the grade or base has been placed and compacted to the specified density, the areas which will support the paving machine and the area upon which the pavement is to be placed shall be cut to the proper elevation by means of an approved machine.

502.16.2 Placing Concrete. A self-propelled concrete spreader equipped with a power-driven device for spreading the concrete uniformly across the subgrade transversely shall be used to place the concrete. The spreader shall also be equipped with an adjustable strike-off blade capable of striking off the surface of the concrete in the longitudinal direction of the pavement at any required elevation. For isolated pavement lanes over 200 feet (60 m) long but less than 2000 feet (600 m) long, a mechanical spreader will not be required.

502.16.3 Consolidating and Finishing Equipment. The concrete shall be consolidated and finished by a slip-form paver designed to spread, consolidate and shape the concrete in one complete pass of the machine in such a manner to provide a smooth, dense and homogeneous pavement in conformance with the plans and specifications. Hand finishing is discouraged. The slip-form paver shall be fully energized, self-propelled and crawler mounted. It shall be of sufficient weight (mass) and power to construct the maximum specified concrete paving lane width as shown on the plans at an adequate forward speed, and without transverse, longitudinal or vertical instability or displacement. The slip-form paver shall produce a surface reasonably free of surface voids and tears. The machine shall satisfactorily vibrate the concrete for the full width and depth of the pavement being placed. No apparent slumping of the concrete shall occur 6 inches (150 mm) or more in from the pavement edge. All operations of mixing, delivering and spreading concrete shall be so coordinated as to provide uniform progress with stopping and starting of the paver held to a minimum. If it is necessary to stop the forward movement of the paver, the vibratory and tamping elements shall also be stopped immediately.

502.16.4 Forms. Forms shall be used where necessary to produce a pavement of plan section and shall incorporate a keyway where required.

502.16.4.1 Longitudinal tongue and groove joints of the specified type and size shall be constructed at locations shown on the plans or approved by the engineer. The groove side of the joint shall be slip-formed or formed with approved metal forms that will produce a keyway conforming to plan location and dimensions. The form shall remain in place for sufficient time to prevent slump. Metal forms may be left in place if approved by the engineer. The tongue side of the joint may be constructed without forms provided the plan section of the pavement and joint is maintained.

502.16.4.2 Where tie bars are required at longitudinal construction joints, a tongue and groove type joint shall be constructed and the tie bars shall be installed in the groove side of the joint. The bars shall be positioned before pavement consolidation.

502.16.5 Protection Against Rain. To protect against the effects of rain, the contractor shall have on location at all times material for the protection of the edges and surface of the unhardened concrete. It is the contractor's responsibility to protect the pavement from damage due to rain. Failure to properly protect unhardened concrete may constitute cause for the removal and replacement of defective pavement at the contractor's expense.

502.17 Material Acceptance. Acceptance will be based on test results indicating the concrete pavement meets the specification requirements, the contractor following the approved Quality Control Plan (QCP), and favorable comparison of the contractor's quality control tests and the engineer's quality acceptance tests. Favorable comparison will be based on the QA tests comparing within two standard deviations of the QC test results for each individual lot of material. For properties not evaluated on a lot basis, favorable comparison will be based on both the QC and QA tests meeting the specification requirements. Compressive strength and pavement thickness will be evaluated on a lot basis.

502.17.1 Lot Definition. A lot shall be the surface area placed in a single day. Normally, divide a lot representing a day's production into four sublots of approximately equal surface area. For high daily production rates exceeding 7500 square yards (6275 m^2) per day, the contractor may choose to divide the day's production into two approximately equal lots consisting of four sublots each. The contractor shall notify the engineer of the decision to divide a days' production into two equal lots prior to taking any core samples. When a day's production involves less than 600 square yards (500 m^2) combine the following day or days production to reach 600 square yards (500 m^2) and treat as a single lot, except while completing a particular mix design or project, combine with the previous day's production and treat as a

single lot. If a project or mix design has less than 600 square yards (500 m^2), a lot may be less than 600 square yards (500 m^2).

502.17.2 Sampling. One QC sample shall be taken for each sublot and one QA sample shall be taken per lot. A sample shall be taken from the finished concrete consisting of a 4-inch (100 mm) diameter core for concrete pavements less than 12 inches (300 mm) thick and a 6-inch (150 mm) diameter core for concrete pavements 12 inches or greater. Sampling locations will be determined by the engineer using random sampling procedures in accordance with ASTM D 3665.

502.17.3 Coring. Cores shall be taken in accordance with AASHTO T 24. Cores shall be neatly cut with a core drill. The contractor shall furnish all tools, labor and material for cutting samples and filling the cored hole. The contractor shall fill the core holes with an approved non-shrink grout within one day after sampling.

502.17.3.1 The core thickness shall be determined by the average caliper measurement in accordance with AASHTO T 148. After the thickness is determined, the cores shall be sawed to an L/D ratio of 2.0 and tested in accordance with AASHTO T 22. Cores shall not be taken until a minimum compressive strength of 3000 pounds per square inch (21 MPa) has been attained. The contractor shall be responsible for determining the compressive strength by approved methods. Cores shall be tested for compressive strength 28 days after placement.

502.17.3.2 If the contractor elects to diamond grind to improve the smoothness of the pavement or diamond grinding is required in accordance with Sec 502.10.2, re-coring of the pavement for PWL thickness acceptance will be required for all lots that were previously determined to be at plan thickness or less. The engineer may require re-coring, regardless of the initial pavement thickness, if two or more diamond grinding passes are conducted within a given lot. Cores shall be 4-inch (100 mm) diameter. Location of coring will be determined by the engineer using random sampling procedures in accordance with ASTM D 3665.

502.17.4 Acceptance. Compressive strength, and thickness shall be evaluated for acceptance on a lot basis using the method of estimating PWL. Acceptance using PWL will consider the variability (standard deviation) of the material and the testing procedures, as well as the average (mean) value of the test results to calculate the percentage of material that is above the lower specification tolerance limit (LSL) for compressive strength and thickness.

502.17.4.1 The PWL will be based on the mean, standard deviation and quality index of each lot's test results as follows:

Mean

$$x_a = \sum \frac{x_i}{n}$$

where:

x_a = Mean of the individual values being considered
$\sum x_i$ = The summation of all the individual values being considered
n = The number of individual values under consideration

Standard Deviation

$$s = \sqrt{\frac{\sum (x_i - x_a)^2}{n-1}}$$

Where:

s = Standard Deviation

Upper Quality Index

$$Q_U = \frac{USL - x_a}{s}$$

Lower Quality Index

$$Q_L = \frac{x_a - LSL}{s}$$

Where:

Q_U = Upper Quality Index
Q_L = Lower Quality Index
USL = Pay Factor Item Upper Spec Limit
LSL = Pay Factor Item Lower Spec Limit

502.17.4.2 The upper (PWL_U) and lower (PWL_L) will be determined from Table I. Total percent within limits is: $PWL_t = (PWL_U + PWL_L) - 100$. For thickness and compressive strength in this specification, PWL_U shall be 100.

502.17.4.3 The engineer will make the QLA within 24 hours after receipt of the contractor's test results, by determining the PWL_t for each designated pay factor item. The contractor's test results will be used when applicable to determine the PWL, provided the contractor's QC tests and the engineer's QA tests compare favorably, and provided the engineer's inspection and monitoring activities indicate the contractor is following the approved QC Plan.

502.17.4.4 The engineer may at any time reject and require the contractor to dispose of any batch of concrete mixture which is rendered unfit for use due to contamination, segregation, improper slump or improper entrained air content. Such rejection may be based on only visual inspection. In the event of such rejection, the contractor may take a representative sample of the rejected material in the presence of the engineer, and if it can be demonstrated in the laboratory, in the presence of the engineer, that such material was erroneously rejected, payment will be made for the material at the contract unit price.

502.17.4.5 The lower specification limit (LSL) for compressive strength and thickness shall be:

(a) Compressive Strength – 4,650 psi (32.1 MPa).

(b) Thickness – Plan Thickness minus 2/10 inch (5 mm).

502.17.5 Outliers. Individual compressive strength tests within a lot may be checked for an outlier in accordance with the determination of statistic T in ASTM E 178, at a significance level of 5 percent. Replacement cores shall be obtained at the location designated and in the presence of the engineer. The PWL shall be determined using the replacement values.

502.18 Contractor Quality Control.

502.18.1 Quality Control Plan. The contractor shall develop a Quality Control Plan (QCP) that addresses all elements which affect the quality of the pavement including, but not limited to mix design, aggregate gradation, quality of material, stockpile management, proportioning, mixing and transportation, placing and consolidation, joints, dowel placement and alignment, compressive strength, pavement thickness, entrained air content, finishing and curing, and surface smoothness. The QCP shall be approved by Project Operations prior to placing any concrete.

502.18.2 Quality Control Testing. The contractor shall perform all quality control tests necessary to control the production and construction processes applicable to this specification and as set forth in the QCP. Quality control testing shall be performed qualified through MoDOT's technician certification program. Testing shall include, but not necessarily be limited to, tests for aggregate gradation and deleterious material, aggregate moisture content, entrained air content and slump.

502.18.2.1 Fine and Coarse Aggregate.

502.18.2.1.1 Gradation and Deleterious Material. A sieve analysis shall be made at least twice daily in accordance with AASHTO T 27 from randomly sampled material taken from the discharge gate of storage bins or from the conveyor belt. Deleterious substance shall be determined from these random samples in accordance with MoDOT Test Method T71.

502.18.2.1.2 Moisture Content. If an electric moisture meter is used, at least two direct measurements of moisture content shall be made per week to check the calibration. If direct measurements are made for fine or coarse aggregate in lieu of using an electric meter, two tests shall be made per day in accordance with AASHTO T 255.

502.18.2.2 Slump. Slump tests shall be performed on a random basis for each 500 cubic yards (375 m^3) of material produced. The engineer will designate the random location at the time of sampling. If a day's material production does not exceed 500 cubic yards (375 m^3), one slump test shall be performed. Slump tests shall be in accordance with AASHTO T 119 from randomly sampled material discharged from trucks at the paving site. Material samples shall be in accordance with AASHTO T 141.

502.18.2.3 Entrained Air Content. Tests for entrained air content shall be performed on a random basis for each 500 cubic yards (375 m^3) of material produced. The engineer will designate the random location at the time of sampling. The target air content in front of the paver is 7.0 percent plus the air loss through the paver. The air loss through the paver is determined once per half-day production by sampling the concrete ahead of the paver and behind the paver and subtracting the value obtained ahead of the paver from the value obtained behind the paver. The engineer shall be given notification prior to determining the air loss in order to witness the air loss determination. On the first day of paving, the target air content shall be determined immediately after placing 200 cubic yards (150 m^3) of concrete. The entrained air content of the first 200 cubic yards (150 m^3) of concrete placed on the first day of paving, sampled in front of the paver, shall be greater than 7.0 percent. Tests shall be in accordance with AASHTO T 152.

502.18.3 Control Charts. The contractor shall maintain linear control charts for fine and coarse aggregate gradation, slump, entrained air content, time taken and loss through the paver, compressive strength (either by cylinders or maturity) and pavement thickness. Control charts shall be posted in a location satisfactory to the engineer and shall be kept up to date at all times. As a minimum, the control charts shall identify the project number, the contract item number, the test number, each test parameter, the action and suspension limits (or specification limits) applicable to each test parameter, and the contractor's test results. The contractor shall use the control charts as part of a process control system for identifying potential problems and assignable causes before they occur. If the contractor's projected data during production indicates a potential problem and the contractor is not taking satisfactory corrective action, the engineer may halt production or acceptance of the material.

502.18.3.1 Fine and Coarse Aggregate Gradation. The contractor shall record the gradation tests for each control sieve on linear control charts. Specification limits from Sec 1005, or the limits established in the QC plan for optimized mixtures, shall be superimposed on the control chart for job control.

502.18.3.2 Slump and Air Content. The contractor shall maintain linear control charts for both individual measurements of slump and air content in accordance with the following action and suspension limits. The individual measurement control charts shall use the mix design target values as indicators of central tendency.

Control Parameter	Individual Measurements	
	Action Limit	Suspension Limit
Slip Form:		
Slump	+0 to –1" (0-25 mm)	+0.5 to –1.5" (13-38 mm)
Air Content	+/- 1.2%	+/- 1.5%
Fixed Form:		
Slump	+0.5 to –1" (13-25 mm)	+1 to –1.5" (13-38 mm)
Air Content	+/- 1.2%	+/- 1.5%
Gradation		
Aggregate	+/- 2%	+/- 3%
-200	+0.5%	+0.7%

502.18.4 Corrective Action. The QCP shall indicate that appropriate action shall be taken when a process is believed to be out of control. The QCP shall detail what action shall be taken to bring a process into control and shall contain sets of rules to gauge when a process is out of control. As a minimum, a process shall be deemed out of control and corrective action taken if any one of the below conditions exists. In addition, each truckload of material enroute prior to halting production shall be tested for specification compliance.

502.18.4.1 Fine and Coarse Aggregate Gradation. When two consecutive tests are outside the action limits or one outside the suspension limits, immediate steps, including a halt to production, shall be taken to correct the gradation.

502.18.4.2 Fine and Coarse Aggregate Moisture Content. Whenever the moisture content of the fine or coarse aggregate changes by more than 0.5 percent, the scale settings for the aggregate batcher(s) and water batcher shall be adjusted.

502.18.4.3 Slump and Air Content. The contractor shall halt production and make appropriate adjustments whenever either of the following occurs:

(a) One point falls outside the suspension limit line for individual measurements or range.

(b) Two points in a row fall outside the action limit line for individual measurements.

(c) All material with an entrained air content less than 4.0 percent shall be removed and replaced at the contractor's expense.

502.19 Quality Assurance. Corrective action shall be required in accordance with Sec 502.18.4 for any QA tests outside the suspension limit. The engineer will at a minimum, independently test at the following frequency:

Compressive Strength	1 per lot
Thickness	1 per lot
Surface Texture	1 per lot
Slump	1 per day
Entrained Air Content	1 per day
Aggregate Gradation	1 per 2 days
Aggregate Moisture	1 per 2 days

502.20 Method of Measurement. Pavement areas will be computed to the nearest 1/10 square yard (0.1 m^2). Final measurement of the completed pavement will not be made except for authorized changes during construction, or where appreciable errors are found in the contract quantity. The revision or correction will be computed and added to or deducted from the contract quantity.

502.21 Basis of Payment.

502.21.1 Pavement thickness determination will be made after all smoothness correction has been completed. If any core measurement of thickness is greater than 0.6 inch (15 mm) deficient, or any core measurement of compressive strength is less than 3500 PSI the contractor shall remove and replace the pavement in that sublot at the contractor's expense.

502.21.2 For marred surface areas or slightly damaged concrete that remains in the completed pavement, a minimum deduction of 20 percent of the contract unit price will be made for the areas affected. The deduction will be applied to a section of pavement extending from edge of the pavement to a longitudinal joint or between longitudinal joints in that section of pavement affected. If the length of the section affected is less than 10 feet (3 m), the deduction will be computed for 10 feet (3 m). Areas corrected for smoothness will not be considered marred surfaces.

502.21.3 Payment for smoothness shall be based on either Table I or Table II. Table I shall be used for pavements having a final posted speed greater than 45 mph (70 km/h). Table II shall be used for pavements having a final posted speed of 45 mph (70 km/h) or less and for pavements with no posted speed limits. Constant width acceleration and deceleration lanes shall be considered as mainline pavements.

502.21.3.1 If the contractor elects to only perform bump correction, smoothness incentive will be paid per section based on the profile index before bump correction. If diamond grinding is conducted as the final texturing of the pavement surface, smoothness incentive will be paid per section based on the profile index after diamond grinding. Within a section qualifying for incentive pay, any segment having a profile index requiring a reduction in contract price will not be included in incentive payment for that section.

502.21.3.2 Deductions for rough pavement shall be based on Table I for pavements having a final posted speed greater than 45 mph (70 km/h) and Table II for pavements having a final

posted speed of 45 mph (70 km/h) or less and for pavements with no posted speed limits. Constant width acceleration and deceleration lanes shall be considered as mainline pavements. Deductions will be applied to pavements based on the average segment index after initial 0.4 bump correction.

Table I	
Segment Profile Inches, Inches Per Mile (mm/km)	**Percent of Contract Price**
9.0 (142) or less	110
9.1 - 12.0 (143 - 190)	107
12.1 - 15.0 (191 - 237)	100
15.1 – 18.0 (238 – 284)	93
18.1 - 25.0 (285 - 395)	90
25.1 (396) or greater	90*

Table II	
Segment Profile Inches, Inches Per Mile (mm/km)	**Percent of Contract Price**
15.0 (237) or less	105
15.1 - 25.0 (238 - 395)	103
25.1 - 45.0 (396 - 711	100
45.1 - 55.0 (712 - 869)	97*
55.1 - 65.0 (870 - 1026)	95*
65.1 (1027) or greater	93*

*Correction required.

502.21.3.3 After initial bump correction, segments with an average profile index of 25.1 (396) or greater (Table I), or 45.1 (712) or greater (Table II), shall be corrected as specified in Sec 502.14.6 until the profile index is 25.0 (395) or less (Table I), or 45.0 (711) or less (Table II). At the contractor's option, these segments may be removed and replaced to obtain 100% payment and eliminate grinding if retests verify that new segment indexes meet above requirements. Where Table II is applicable, any correction results will not be applied to the initial section index for increasing bonus payment.

502.21.3.4 On sections where corrections are made, the pavement shall be tested by the contractor to verify that corrections have produced a profile index of 25.0 (395) or less (Table I), or 45.0 (711) or less (Table II).

502.21.3.5 Where Table II is applicable, the contractor will not be allowed to make corrective grinding to increase the percent of pay when the final profile index is 45.0 (711) or less.

502.21.4 If the profile index, after bump correction, is 25.1 (396) or greater (Table I), or 45.1 (712) or greater (Table II), and the contractor elects to remove and replace the segment, the contractor will be paid the percent of contract price that corresponds to the replaced segment's profile index as specified above.

502.21.5 The contract unit price for portland cement concrete pavement will be considered as full compensation for all material, including reinforcement, dowels, dowel supports, tie bars and any other items entering into the construction of the traveled way pavement or portland cement concrete shoulders, and for the cost of smoothness testing. No additional compensation will be allowed for any excess thickness.

502.21.6 The accepted quantities of portland cement concrete pavement will be paid for at the contract unit price with proper allowance made for any deductions for deficiency in thickness, smoothness or marred surface.

502.21.7 When paving widths are greater than the travel lane widths, payment for profiling will apply to the traffic lane design driving width only, normally 12 feet (3.6 m). Random lane coring for thickness or required lane replacement will include the full paved lane width to the longitudinal joints or edge of shoulder, whichever is first.

502.21.8 Pay Factors. The total pay factor (PF_t) for each lot is equal to the weighted sum of the pay factors (PF) for each pay factor item for each lot, and is determined as follows:

PF_t = + (0.5) PF_T + (0.5) PF_{CS}

Where: PF_T = Pay Factor for Thickness

PF_{CS} = Pay Factor for Compressive Strength

The PF for each pay factor item for each lot is based on the PWL_t of each pay factor item of each lot and is determined as follows:

When PWL_t is greater than or equal to 70: PF = 0.5 PWL_t + 55

When PWL_t is less than 70: PF = 2 PWL_t - 50

502.21.9 PWL Determination Table. Numbers in the body of this table are estimates of the PWL corresponding to specific values of Q, the Quality Index. For Q values less than zero, subtract the table value from 100.

TABLE I
Variability-Unknown Procedure
Standard-Deviation Method

Quality Index	PWL For Selected Sample Sizes							
(Q_U or Q_L)	n=3	n=4	n=5	n=6	n=7	n=8	n=9	n=10
0.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
0.01	50.28	50.33	50.36	50.37	50.37	50.38	50.38	50.38
0.02	50.55	50.67	50.71	50.74	50.75	50.76	50.76	50.77
0.03	50.83	51.00	51.07	51.10	51.12	51.13	51.15	51.15
0.04	51.10	51.34	51.42	51.47	51.50	51.51	51.53	51.54
0.05	51.38	51.67	51.78	51.84	51.87	51.89	51.91	51.92
0.06	51.66	52.00	52.14	52.21	52.24	52.27	52.29	52.30
0.07	51.93	52.33	52.49	52.57	52.62	52.65	52.67	52.69
0.08	52.21	52.67	52.85	52.94	52.99	53.02	53.06	53.07
0.09	52.48	53.00	53.20	53.30	53.37	53.40	53.44	53.46
0.10	52.76	53.33	53.56	53.67	53.74	53.78	53.82	53.84
0.11	53.04	53.66	53.91	54.04	54.11	54.16	54.20	54.22
0.12	53.32	54.00	54.27	54.40	54.48	54.54	54.58	54.60
0.13	53.59	54.33	54.62	54.77	54.86	54.91	54.95	54.99
0.14	53.87	54.67	54.98	55.13	55.23	55.29	55.33	55.37
0.15	54.15	55.00	55.33	55.50	55.60	55.67	55.71	55.75
0.16	54.43	55.33	55.68	55.86	55.97	56.04	56.09	56.13
0.17	54.71	55.67	56.04	56.23	56.34	56.42	56.47	56.51
0.18	54.98	56.00	56.39	56.59	56.72	56.79	56.84	56.89
0.19	55.26	56.34	56.75	56.96	57.09	57.17	57.22	57.27
0.20	55.54	56.67	57.10	57.32	57.46	57.54	57.60	57.65
0.21	55.82	57.00	57.45	57.68	57.83	57.91	57.98	58.03
0.22	56.10	57.33	57.81	58.05	58.20	58.29	58.35	58.40

TABLE I Variability-Unknown Procedure Standard-Deviation Method								
Quality Index	**PWL For Selected Sample Sizes**							
(Q_U or Q_L)	**n=3**	**n=4**	**n=5**	**n=6**	**n=7**	**n=8**	**n=9**	**n=10**
0.23	56.39	57.67	58.16	58.41	58.56	58.66	58.73	58.78
0.24	56.67	58.00	58.52	58.78	58.93	59.04	59.10	59.15
0.25	56.95	58.33	58.87	59.14	59.30	59.41	59.48	59.53
0.26	57.23	58.66	59.22	59.50	59.67	59.78	59.85	59.90
0.27	57.52	59.00	59.57	59.86	60.03	60.15	60.22	60.28
0.28	57.80	59.33	59.93	60.22	60.40	60.51	60.60	60.65
0.29	58.09	59.67	60.28	60.58	60.76	60.88	60.97	61.03
0.30	58.37	60.00	60.63	60.94	61.13	61.25	61.34	61.40
0.31	58.66	60.33	60.98	61.30	61.49	61.62	61.71	61.77
0.32	58.94	60.67	61.33	61.66	61.85	61.98	62.08	62.14
0.33	59.23	61.00	61.68	62.01	62.22	62.35	62.44	62.51
0.34	59.51	61.34	62.03	62.37	62.58	62.71	62.81	62.88
0.35	59.80	61.67	62.38	62.73	62.94	63.08	63.18	63.25
0.36	60.09	62.00	62.73	63.09	63.30	63.44	63.54	63.61
0.37	60.38	62.33	63.08	63.44	63.66	63.80	63.91	63.98
0.38	60.68	62.67	63.42	63.80	64.02	64.17	64.27	64.34
0.39	60.97	63.00	63.77	64.15	64.38	64.53	64.64	64.71
0.40	61.26	63.33	64.12	64.51	64.74	64.89	65.00	65.07
0.41	61.56	63.66	64.46	64.86	65.09	65.25	65.36	65.43
0.42	61.85	64.00	64.81	65.21	65.45	65.60	65.72	65.79
0.43	62.15	64.33	65.15	65.57	65.80	65.96	66.07	66.15
0.44	62.44	64.67	65.50	65.92	66.16	66.31	66.43	66.51
0.45	62.74	65.00	65.84	66.27	66.51	66.67	66.79	66.87
0.46	63.04	65.33	66.18	66.62	66.86	67.02	67.14	67.22
0.47	63.34	65.67	66.53	66.96	67.21	67.37	67.49	67.57
0.48	63.65	66.00	66.87	67.31	67.56	67.73	67.85	67.93
0.49	63.95	66.34	67.22	67.65	67.91	68.08	68.20	68.28
0.50	64.25	66.67	67.56	68.00	68.26	68.43	68.55	68.63
0.51	64.56	67.00	67.90	68.34	68.61	68.78	68.90	68.98
0.52	64.87	67.33	68.24	68.69	68.95	69.12	69.24	69.32
0.53	65.18	67.67	68.58	69.03	69.30	69.47	69.59	69.67
0.54	65.49	68.00	68.92	69.38	69.64	69.81	69.93	70.01
0.55	65.80	68.33	69.26	69.72	69.99	70.16	70.28	70.36
0.56	66.12	68.66	69.60	70.06	70.33	70.50	70.62	70.70
0.57	66.44	69.00	69.94	70.40	70.67	70.84	70.96	71.04
0.58	66.75	69.33	70.27	70.73	71.00	71.17	71.29	71.38
0.59	67.07	69.67	70.61	71.07	71.34	71.51	71.63	71.72
0.60	67.39	70.00	70.95	71.41	71.68	71.85	71.97	72.06
0.61	67.72	70.33	71.28	71.74	72.01	72.11	72.30	72.39
0.62	68.05	70.67	71.61	72.08	72.34	72.37	72.63	72.72
0.63	68.37	71.00	71.95	72.41	72.68	72.63	72.97	73.06
0.64	68.70	71.34	72.28	72.75	73.01	72.89	73.30	73.39
0.65	69.03	71.67	72.61	73.08	73.34	73.15	73.63	73.72
0.66	69.37	72.00	72.94	73.41	73.67	73.55	73.95	74.04
0.67	69.71	72.33	73.27	73.73	73.99	73.95	74.28	74.36
0.68	70.05	72.67	73.60	74.06	74.32	74.35	74.60	74.69
0.69	70.39	73.00	73.93	74.38	74.64	74.75	74.93	75.01
0.70	70.73	73.33	74.26	74.71	74.97	75.15	75.25	75.33
0.71	71.08	73.66	74.59	75.03	75.29	75.46	75.57	75.64

TABLE I Variability-Unknown Procedure Standard-Deviation Method								
Quality Index	**PWL For Selected Sample Sizes**							
(Q_U or Q_L)	**n=3**	**n=4**	**n=5**	**n=6**	**n=7**	**n=8**	**n=9**	**n=10**
0.72	71.44	74.00	74.91	75.35	75.61	75.78	75.88	75.96
0.73	71.79	74.33	75.24	75.68	75.92	76.09	76.20	76.27
0.74	72.15	74.67	75.56	76.00	76.24	76.41	76.51	76.59
0.75	72.50	75.00	75.89	76.32	76.56	76.72	76.83	76.90
0.76	72.87	75.33	76.21	76.63	76.87	77.03	77.14	77.21
0.77	73.24	75.67	76.53	76.95	77.18	77.34	77.44	77.51
0.78	73.62	76.00	76.85	77.26	77.50	77.64	77.75	77.82
0.79	73.99	76.34	77.17	77.58	77.81	77.95	78.05	78.12
0.80	74.36	76.67	77.49	77.89	78.12	78.26	78.36	78.43
0.81	74.75	77.00	77.81	78.20	78.42	78.56	78.66	78.72
0.82	75.15	77.33	78.12	78.51	78.72	78.86	78.95	79.02
0.83	75.54	77.67	78.44	78.81	79.03	79.16	79.25	79.31
0.84	75.94	78.00	78.75	79.12	79.33	79.46	79.54	79.61
0.85	76.33	78.33	79.07	79.43	79.63	79.76	79.84	79.90
0.86	76.75	78.66	79.38	79.73	79.92	80.05	80.13	80.19
0.87	77.18	79.00	79.69	80.03	80.22	80.34	80.42	80.47
0.88	77.60	79.33	80.00	80.33	80.51	80.63	80.70	80.76
0.89	78.03	79.67	80.31	80.63	80.81	80.92	80.99	81.04
0.90	78.45	80.00	80.62	80.93	81.10	81.21	81.28	81.33
0.91	78.91	80.33	80.92	81.22	81.38	81.49	81.56	81.61
0.92	79.37	80.67	81.23	81.51	81.67	81.77	81.84	81.88
0.93	79.83	81.00	81.53	81.81	81.95	82.05	82.11	82.16
0.94	80.29	81.34	81.84	82.10	82.24	82.33	82.39	82.43
0.95	80.75	81.67	82.14	82.39	82.52	82.61	82.67	82.71
0.96	81.27	82.00	82.44	82.67	82.80	82.88	82.94	82.97
0.97	81.78	82.33	82.74	82.95	83.07	83.15	83.20	83.24
0.98	82.30	82.67	83.04	83.24	83.35	83.42	83.47	83.50
0.99	82.81	83.00	83.34	83.52	83.62	83.69	83.73	83.77
1.00	83.33	83.33	83.64	83.80	83.90	83.96	84.00	84.03
1.01	83.93	83.66	83.93	84.08	84.17	84.22	84.26	84.28
1.02	84.53	84.00	84.22	84.35	84.43	84.48	84.51	84.53
1.03	85.14	84.33	84.51	84.63	84.70	84.74	84.77	84.79
1.04	85.74	84.67	84.80	84.90	84.96	85.00	85.02	85.04
1.05	86.34	85.00	85.09	85.18	85.23	85.26	85.28	85.29
1.06	87.10	85.33	85.38	85.44	85.49	85.51	85.53	85.53
1.07	87.87	85.67	85.66	85.71	85.74	85.76	85.77	85.77
1.08	88.63	86.00	85.95	85.97	86.00	86.01	86.02	86.02
1.09	89.40	86.34	86.23	86.24	86.25	86.26	86.26	86.26
1.10	90.16	86.67	86.52	86.50	86.51	86.51	86.51	86.50
1.11	91.55	87.00	86.80	86.76	86.75	86.75	86.74	86.73
1.12	92.95	87.33	87.07	87.01	87.00	86.99	86.98	86.96
1.13	94.34	87.67	87.35	87.27	87.24	87.22	87.21	87.20
1.14	95.74	88.00	87.62	87.52	87.49	87.46	87.45	87.43
1.15	97.13	88.33	87.90	87.78	87.73	87.70	87.68	87.66
1.16	100.00	88.66	88.17	88.03	87.96	87.93	87.90	87.88
1.17	100.00	89.00	88.44	88.27	88.20	88.15	88.12	88.10
1.18	100.00	89.33	88.70	88.52	88.43	88.38	88.35	88.32
1.19	100.00	89.67	88.97	88.76	88.67	88.60	88.57	88.54
1.20	100.00	90.00	89.24	89.01	88.90	88.83	88.79	88.76

TABLE I Variability-Unknown Procedure Standard-Deviation Method								
Quality Index	**PWL For Selected Sample Sizes**							
(Q_U or Q_L)	**n=3**	**n=4**	**n=5**	**n=6**	**n=7**	**n=8**	**n=9**	**n=10**
1.21	100.00	90.33	89.50	89.25	89.12	89.05	89.00	88.97
1.22	100.00	90.67	89.76	89.48	89.35	89.26	89.21	89.17
1.23	100.00	91.00	90.02	89.72	89.57	89.48	89.43	89.38
1.24	100.00	91.34	90.28	89.95	89.80	89.69	89.64	89.58
1.25	100.00	91.67	90.54	90.19	90.02	89.91	89.85	89.79
1.26	100.00	92.00	90.79	90.41	90.23	90.12	90.05	89.99
1.27	100.00	92.33	91.04	90.64	90.44	90.32	90.25	90.19
1.28	100.00	92.67	91.29	90.86	90.65	90.53	90.44	90.38
1.29	100.00	93.00	91.54	91.09	90.86	90.73	90.64	90.58
1.30	100.00	93.33	91.79	91.31	91.07	90.94	90.84	90.78
1.31	100.00	93.66	92.03	91.52	91.27	91.13	91.03	90.96
1.32	100.00	94.00	92.27	91.73	91.47	91.32	91.22	91.15
1.33	100.00	94.33	92.50	91.95	91.68	91.52	91.40	91.33
1.34	100.00	94.67	92.74	92.16	91.88	91.71	91.59	91.52
1.35	100.00	95.00	92.98	92.37	92.08	91.90	91.78	91.70
1.36	100.00	95.33	93.21	92.57	92.27	92.08	91.96	91.87
1.37	100.00	95.67	93.44	92.77	92.46	92.26	92.14	92.04
1.38	100.00	96.00	93.66	92.97	92.64	92.45	92.31	92.22
1.39	100.00	96.34	93.89	93.17	92.83	92.63	92.49	92.39
1.40	100.00	96.67	94.12	93.37	93.02	92.81	92.67	92.56
1.41	100.00	97.00	94.33	93.56	93.20	92.98	92.83	92.72
1.42	100.00	97.33	94.55	93.75	93.37	93.15	93.00	92.88
1.43	100.00	97.67	94.76	93.94	93.55	93.31	93.16	93.05
1.44	100.00	98.00	94.98	94.13	93.72	93.48	93.33	93.21
1.45	100.00	98.33	95.19	94.32	93.90	93.65	93.49	93.37
1.46	100.00	98.66	95.39	94.49	94.06	93.81	93.64	93.52
1.47	100.00	99.00	95.59	94.67	94.23	93.97	93.80	93.67
1.48	100.00	99.33	95.80	94.84	94.39	94.12	93.95	93.83
1.49	100.00	99.67	96.00	95.02	94.56	94.28	94.11	93.98
1.50	100.00	100.00	96.20	95.19	94.72	94.44	94.26	94.13
1.51	100.00	100.00	96.39	95.35	94.87	94.59	94.40	94.27
1.52	100.00	100.00	96.57	95.51	95.02	94.73	94.54	94.41
1.53	100.00	100.00	96.76	95.68	95.18	94.88	94.69	94.54
1.54	100.00	100.00	96.94	95.84	95.33	95.02	94.83	94.68
1.55	100.00	100.00	97.13	96.00	95.48	95.17	94.97	94.82
1.56	100.00	100.00	97.30	96.15	95.62	95.30	95.10	94.95
1.57	100.00	100.00	97.47	96.30	95.76	95.44	95.23	95.08
1.58	100.00	100.00	97.63	96.45	95.89	95.57	95.36	95.20
1.59	100.00	100.00	97.80	96.60	96.03	95.71	95.49	95.33
1.60	100.00	100.00	97.97	96.75	96.17	95.84	95.62	95.46
1.61	100.00	100.00	98.12	96.88	96.30	95.96	95.74	95.58
1.62	100.00	100.00	98.27	97.02	96.43	96.08	95.86	95.70
1.63	100.00	100.00	98.42	97.15	96.55	96.21	95.98	95.81
1.64	100.00	100.00	98.57	97.29	96.68	96.33	96.10	95.93
1.65	100.00	100.00	98.72	97.42	96.81	96.45	96.22	96.05
1.66	100.00	100.00	98.84	97.54	96.92	96.56	96.33	96.16
1.67	100.00	100.00	98.97	97.66	97.04	96.67	96.44	96.27
1.68	100.00	100.00	99.09	97.78	97.15	96.79	96.54	96.37
1.69	100.00	100.00	99.22	97.90	97.27	96.90	96.65	96.48

TABLE I Variability-Unknown Procedure Standard-Deviation Method								
Quality Index	**PWL For Selected Sample Sizes**							
(Q_U or Q_L)	**n=3**	**n=4**	**n=5**	**n=6**	**n=7**	**n=8**	**n=9**	**n=10**
1.70	100.00	100.00	99.34	98.02	97.38	97.01	96.76	96.59
1.71	100.00	100.00	99.43	98.13	97.48	97.11	96.86	96.69
1.72	100.00	100.00	99.53	98.23	97.58	97.21	96.96	96.78
1.73	100.00	100.00	99.62	98.34	97.69	97.31	97.05	96.88
1.74	100.00	100.00	99.72	98.44	97.79	97.41	97.15	96.97
1.75	100.00	100.00	99.81	98.55	97.89	97.51	97.25	97.07
1.76	100.00	100.00	99.86	98.64	97.98	97.60	97.34	97.16
1.77	100.00	100.00	99.91	98.73	98.07	97.69	97.43	97.25
1.78	100.00	100.00	99.95	98.81	98.17	97.78	97.52	97.33
1.79	100.00	100.00	100.00	98.90	98.26	97.87	97.61	97.42
1.80	100.00	100.00	100.00	98.99	98.35	97.96	97.70	97.51
1.81	100.00	100.00	100.00	99.06	98.43	98.04	97.78	97.59
1.82	100.00	100.00	100.00	99.14	98.51	98.12	97.86	97.67
1.83	100.00	100.00	100.00	99.21	98.58	98.19	97.93	97.75
1.84	100.00	100.00	100.00	99.29	98.66	98.27	98.01	97.83
1.85	100.00	100.00	100.00	99.36	98.74	98.35	98.09	97.91
1.86	100.00	100.00	100.00	99.42	98.81	98.42	98.16	97.98
1.87	100.00	100.00	100.00	99.48	98.87	98.49	98.23	98.05
1.88	100.00	100.00	100.00	99.53	98.94	98.55	98.30	98.11
1.89	100.00	100.00	100.00	99.59	99.00	98.62	98.37	98.18
1.90	100.00	100.00	100.00	99.65	99.07	98.69	98.44	98.25
1.91	100.00	100.00	100.00	99.69	99.13	98.75	98.50	98.31
1.92	100.00	100.00	100.00	99.73	99.18	98.81	98.56	98.37
1.93	100.00	100.00	100.00	99.77	99.24	98.87	98.62	98.44
1.94	100.00	100.00	100.00	99.81	99.29	98.93	98.68	98.50
1.95	100.00	100.00	100.00	99.85	99.35	98.99	98.74	98.56
1.96	100.00	100.00	100.00	99.87	99.39	99.04	98.79	98.61
1.97	100.00	100.00	100.00	99.90	99.44	99.09	98.84	98.67
1.98	100.00	100.00	100.00	99.92	99.48	99.14	98.90	98.72
1.99	100.00	100.00	100.00	99.95	99.53	99.19	98.95	98.78
2.00	100.00	100.00	100.00	99.97	99.57	99.24	99.00	98.83
2.01	100.00	100.00	100.00	99.98	99.60	99.28	99.05	98.88
2.02	100.00	100.00	100.00	99.98	99.64	99.32	99.09	98.92
2.03	100.00	100.00	100.00	99.99	99.67	99.37	99.14	98.97
2.04	100.00	100.00	100.00	99.99	99.71	99.41	99.18	99.01
2.05	100.00	100.00	100.00	100.00	99.74	99.45	99.23	99.06
2.06	100.00	100.00	100.00	100.00	99.76	99.48	99.27	99.10
2.07	100.00	100.00	100.00	100.00	99.79	99.51	99.30	99.14
2.08	100.00	100.00	100.00	100.00	99.81	99.55	99.34	99.18
2.09	100.00	100.00	100.00	100.00	99.84	99.58	99.37	99.22
2.10	100.00	100.00	100.00	100.00	99.86	99.61	99.41	99.26
2.11	100.00	100.00	100.00	100.00	99.88	99.64	99.44	99.29
2.12	100.00	100.00	100.00	100.00	99.89	99.66	99.47	99.32
2.13	100.00	100.00	100.00	100.00	99.91	99.69	99.51	99.36
2.14	100.00	100.00	100.00	100.00	99.92	99.71	99.54	99.39
2.15	100.00	100.00	100.00	100.00	99.94	99.74	99.57	99.42
2.16	100.00	100.00	100.00	100.00	99.95	99.76	99.59	99.45
2.17	100.00	100.00	100.00	100.00	99.96	99.78	99.62	99.48
2.18	100.00	100.00	100.00	100.00	99.97	99.80	99.64	99.50

TABLE I Variability-Unknown Procedure Standard-Deviation Method								
Quality Index	**PWL For Selected Sample Sizes**							
(Q_U or Q_L)	**n=3**	**n=4**	**n=5**	**n=6**	**n=7**	**n=8**	**n=9**	**n=10**
2.19	100.00	100.00	100.00	100.00	99.98	99.82	99.67	99.53
2.20	100.00	100.00	100.00	100.00	99.99	99.84	99.69	99.56
2.21	100.00	100.00	100.00	100.00	99.99	99.85	99.71	99.58
2.22	100.00	100.00	100.00	100.00	99.99	99.87	99.73	99.61
2.23	100.00	100.00	100.00	100.00	100.00	99.88	99.75	99.63
2.24	100.00	100.00	100.00	100.00	100.00	99.90	99.77	99.66
2.25	100.00	100.00	100.00	100.00	100.00	99.91	99.79	99.68
2.26	100.00	100.00	100.00	100.00	100.00	99.92	99.80	99.70
2.27	100.00	100.00	100.00	100.00	100.00	99.93	99.82	99.72
2.28	100.00	100.00	100.00	100.00	100.00	99.94	99.83	99.73
2.29	100.00	100.00	100.00	100.00	100.00	99.95	99.85	99.75
2.30	100.00	100.00	100.00	100.00	100.00	99.96	99.86	99.77
2.31	100.00	100.00	100.00	100.00	100.00	99.96	99.87	99.78
2.32	100.00	100.00	100.00	100.00	100.00	99.97	99.88	99.80
2.33	100.00	100.00	100.00	100.00	100.00	99.97	99.90	99.81
2.34	100.00	100.00	100.00	100.00	100.00	99.98	99.91	99.83
2.35	100.00	100.00	100.00	100.00	100.00	99.98	99.92	99.84
2.36	100.00	100.00	100.00	100.00	100.00	99.98	99.93	99.85
2.37	100.00	100.00	100.00	100.00	100.00	99.99	99.93	99.86
2.38	100.00	100.00	100.00	100.00	100.00	99.99	99.94	99.87
2.39	100.00	100.00	100.00	100.00	100.00	100.00	99.94	99.88
2.40	100.00	100.00	100.00	100.00	100.00	100.00	99.95	99.89
2.41	100.00	100.00	100.00	100.00	100.00	100.00	99.96	99.90
2.42	100.00	100.00	100.00	100.00	100.00	100.00	99.96	99.91
2.43	100.00	100.00	100.00	100.00	100.00	100.00	99.97	99.91
2.44	100.00	100.00	100.00	100.00	100.00	100.00	99.97	99.92
2.45	100.00	100.00	100.00	100.00	100.00	100.00	99.98	99.93
2.46	100.00	100.00	100.00	100.00	100.00	100.00	99.98	99.94
2.47	100.00	100.00	100.00	100.00	100.00	100.00	99.98	99.94
2.48	100.00	100.00	100.00	100.00	100.00	100.00	99.99	99.95
2.49	100.00	100.00	100.00	100.00	100.00	100.00	99.99	99.95
2.50	100.00	100.00	100.00	100.00	100.00	100.00	99.99	99.96
2.51	100.00	100.00	100.00	100.00	100.00	100.00	99.99	99.96
2.52	100.00	100.00	100.00	100.00	100.00	100.00	99.99	99.97
2.53	100.00	100.00	100.00	100.00	100.00	100.00	100.00	99.97
2.54	100.00	100.00	100.00	100.00	100.00	100.00	100.00	99.98
2.55	100.00	100.00	100.00	100.00	100.00	100.00	100.00	99.98
2.56	100.00	100.00	100.00	100.00	100.00	100.00	100.00	99.98
2.57	100.00	100.00	100.00	100.00	100.00	100.00	100.00	99.98
2.58	100.00	100.00	100.00	100.00	100.00	100.00	100.00	99.99
2.59	100.00	100.00	100.00	100.00	100.00	100.00	100.00	99.99
2.60	100.00	100.00	100.00	100.00	100.00	100.00	100.00	99.99
2.61	100.00	100.00	100.00	100.00	100.00	100.00	100.00	99.99
2.62	100.00	100.00	100.00	100.00	100.00	100.00	100.00	99.99
2.63	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
2.64	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
2.65	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00